

WHAT IS CLAIMED IS:

- 1 1. An internal combustion engine with a plurality of cylinders,
2 the engine including an intake manifold and an exhaust manifold, the engine being
3 operated such that the intake manifold pressure generally exceeds the exhaust
4 manifold pressure, the engine further comprising:
5 a low pressure turbocharger including a turbine driven by the exhaust
6 gases and a compressor having an inlet receiving fresh intake air and an outlet
7 providing low pressure charge air;
8 a high pressure turbocharger including a turbine driven by the exhaust
9 gases and a compressor having an inlet receiving the low pressure charge air and an
10 outlet providing high pressure charge air to the intake manifold;
11 an exhaust gas recirculation (EGR) system passively routing a portion
12 of the exhaust gases to the high pressure turbocharger compressor inlet.
- 1 2. The internal combustion engine of claim 1 further comprising:
2 a charge air cooler between the low pressure turbocharger compressor
3 outlet and the high pressure turbocharger compressor inlet.
- 1 3. The internal combustion engine of claim 1 further comprising:
2 a particulate filter located in the EGR system to filter particulate
3 matter from the exhaust gases prior to introduction to the high pressure turbocharger
4 compressor inlet.
- 1 4. The internal combustion engine of claim 1 further comprising:
2 an EGR cooler located in the EGR system to cool the exhaust gases
3 prior to introduction to the high pressure turbocharger compressor inlet.
- 1 5. The internal combustion engine of claim 1 further comprising:
2 a particulate filter located in the EGR system to filter particulate
3 matter from the exhaust gases prior to introduction to the high pressure turbocharger
4 compressor inlet; and

5 an EGR cooler located in the EGR system downstream of the
6 particulate filter to cool the exhaust gases prior to introduction to the high pressure
7 turbocharger compressor inlet.

1 6. The internal combustion engine of claim 1 further comprising:
2 a charge air cooler between the low pressure turbocharger compressor
3 outlet and the high pressure turbocharger compressor inlet;
4 a particulate filter located in the EGR system to filter particulate
5 matter from the exhaust gases prior to introduction to the high pressure turbocharger
6 compressor inlet; and
7 an EGR cooler located in the EGR system downstream of the
8 particulate filter to cool the exhaust gases prior to introduction to the high pressure
9 turbocharger compressor inlet, wherein the exhaust gases are introduced at a
10 location downstream of the charge air cooler.

1 7. The internal combustion engine of claim 1 wherein a
2 compression ratio of the low pressure turbocharger is greater than a compression
3 ratio of the high pressure turbocharger.

1 8. The internal combustion engine of claim 7 wherein the
2 compression ratio of the low pressure turbocharger is greater than 1.5 times the
3 compression ratio of the high pressure turbocharger.

1 9. A method of controlling an internal combustion engine with
2 a plurality of cylinders, the engine including an intake manifold and an exhaust
3 manifold, the engine being operated such that the intake manifold pressure generally
4 exceeds the exhaust manifold pressure, the engine including a low pressure
5 turbocharger including a turbine driven by the exhaust gases and a compressor
6 having an inlet receiving fresh intake air and an outlet providing low pressure
7 charge air, and the engine further including a high pressure turbocharger including
8 a turbine driven by the exhaust gases and a compressor having an inlet receiving the
9 low pressure charge air and an outlet providing high pressure charge air to the
10 intake manifold, the method further comprising:

11 passively routing a portion of the exhaust gases to the high pressure
12 turbocharger compressor inlet to provide exhaust gas recirculation.

1 10. The method of claim 9 further comprising:
2 cooling the low pressure charge air from the low pressure
3 turbocharger compressor outlet prior to the high pressure turbocharger compressor
4 inlet.

1 11. The method of claim 9 further comprising:
2 filtering particulate matter from the exhaust gases prior to
3 introduction to the high pressure turbocharger compressor inlet.

1 12. The method of claim 9 further comprising:
2 cooling the exhaust gases prior to introduction to the high pressure
3 turbocharger compressor inlet.

1 13. The method of claim 9 further comprising:
2 filtering particulate matter from the exhaust gases prior to
3 introduction to the high pressure turbocharger compressor inlet; and
4 after filtering, cooling the exhaust gases prior to introduction to the
5 high pressure turbocharger compressor inlet.

1 14. The method of claim 9 further comprising:
2 cooling the low pressure charge air from the low pressure
3 turbocharger compressor outlet prior to the high pressure turbocharger compressor
4 inlet;
5 filtering particulate matter from the exhaust gases prior to
6 introduction to the high pressure turbocharger compressor inlet; and
7 after filtering, cooling the exhaust gases prior to introduction to the
8 high pressure turbocharger compressor inlet, wherein the exhaust gases are
9 introduced to cooled low pressure charge air.

1 15. The method of claim 9 wherein a compression ratio of the low
2 pressure turbocharger is greater than a compression ratio of the high pressure
3 turbocharger.

1 16. The method of claim 15 wherein the compression ratio of the
2 low pressure turbocharger is greater than 1.5 times the compression ratio of the high
3 pressure turbocharger.